



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁷ : H02K 5/20</p>	<p>A1</p>	<p>(11) International Publication Number: WO 00/24111 (43) International Publication Date: 27 April 2000 (27.04.00)</p>
<p>(21) International Application Number: PCT/GB99/03399 (22) International Filing Date: 21 October 1999 (21.10.99) (30) Priority Data: 9822915.6 21 October 1998 (21.10.98) GB (71) Applicant (for all designated States except US): ELECTRO-DRIVES LIMITED [GB/GB]; Invensys plc, Carlisle Place, London SW1 1BX (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): STONALL, Philip, Gordon [GB/GB]; 56 Victoria Street, Wall Heath, Kingswinford, Werr Midlands DY6 0JL (GB). (74) Agent: BADGER, John, Raymond; Invensys Intellectual Property, Knights House, 2 Parade, Sutton Coldfield B72 1PH (GB).</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</p>
<p>(54) Title: CASING</p> <p>(57) Abstract</p> <p>A casing for an electrical machine having a rotor and a stator (3) which surrounds the rotor comprises a pipe (1) of thermally conductive material for carrying coolant and arranged in contact with the outer surface (2) of the casing. The pipe may comprise a plurality of straight lengths (5) arranged parallel with the rotational axis of a motor and curved end sections (6) to interconnect the straight sections in series with one another.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Cameroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

CASING

This invention relates to a casing for a rotatable electrical machine such as an electric ac or dc motor or a generator.

In general an electrical machine comprises an inner rotor and an outer stator and it is known to provide a casing in the form of a cooling jacket around the stator. For example US Patent 5707667 discloses a jacket comprising two concentric cylinders with coolant flowing in the space between and European Patent Application 793328 discloses a jacket comprising two concentric cylinders, the outer one being corrugated to define a double helical channel carrying coolant.

When an electrical machine having a cooling jacket is used in a situation where the stator is in an evacuated space, electric discharges often occur between the metal parts carrying currents, and a metallic e g steel, cylinder is usually provided in the gap between the rotor and the stator to prevent these unwanted discharges. However, the presence of such a cooling jacket and/or the cylinder, reduces the electrical efficiency of the machine.

It is an object of the present invention to provide a casing which substantially overcomes or reduces the aforementioned disadvantages.

In accordance with the invention a casing for an electrical machine having an inner rotor and an outer stator comprises a pipe of thermally conductive material for carrying coolant maintained in contact with the outer surface of the stator.

Preferably the pipe comprises a plurality of straight lengths located against the outer surface of the stator, for example, in the case of an ac motor, along the outer surface of the motor stator, each length extending axially. The lengths are joined by curved sections so that the coolant flows in one direction along one length and in the opposite direction along the next adjacent length.

Preferably means such as spring means is provided to urge the pipe against the outer surface of the stator. For example the casing may include an outer housing and a plurality of spring clips, positioned internally of the housing, provided to urge the pipe against the outer surface of the machine.

The pipe and the spring means may be embedded in a settable material

such as an epoxy resin.

One embodiment of the invention, a casing for an ac induction motor, will now be described by way of example only with reference to the accompanying drawings of which:-

Figure 1 shows a transverse cross-section through the casing according to the invention secured to the stator of an ac induction motor;

Figure 2 shows a longitudinal cross-section on line A-A of Figure 1;

Figure 3 shows an end view of the pipe and outer surface of the stator; and

Figure 4 shows a developed plan view of the pipe before being secured in position in contact with the outer surface of the stator.

As shown in Figure 1 a casing according to the invention comprises a pipe 1 of stainless steel configured as shown in Figure 3, located against the cylindrical outer surface 2 of the stator 3 of an ac induction motor and within a housing 4, also of stainless steel.

As shown especially in Figure 4 the pipe 1 is shaped to comprise twelve straight lengths 5 joined together by curved e.g semi-circular, sections 6 whereby fluid flowing through the pipe travels first in one direction along one length and then in the opposite direction along the next adjacent length.

The two ends 7 and 8 of the pipe are supported respectively in two apertures in an end ring 9. The two apertures lead into an array of passages 10 formed in a mounting face 11 which is secured to the end ring 9 by circumferentially spaced apart bolts 12. The mounting face 11 is also provided with an aperture 13 to receive a hermetically sealed plug through which cables 15 connecting to the stator windings 14 pass.

Secured to the end ring 9 on the other side to the mounting face 11 is the stainless steel housing 4. This is generally cylindrical and of sufficient length to cover the stator 3 and the ends of the stator windings 14 (see Figure 2). The housing 4 is corrugated and formed with six axially extending channels 16 each having a base 17 which lies directly against the outer surface 2 of the stator. The six regions 18 between the channels 16 are each circumferentially wider than a channel 16. Each region 18 encloses two lengths 5 of the pipe 1. With

the exception of the region 18 containing the two lengths which are connected to the end ring, each region contains a spring clip comprising a rectangular piece of suitable material such as spring steel or plastic sheet bent to have a shallow V cross-section of two halves with a large included obtuse angle. The apex 20 of each clip presses against the interior of the respective region 18 and the two halves press the two lengths 5 within the respective region against the outer surface 2 of the stator 3.

In its natural state i.e. before being assembled into the housing 4, the obtuse angle of each clip 19 is less than that shown in Figure 1. The action of positioning the clips as shown causes the obtuse angle of each to increase. There is no need for a clip in the region containing the two lengths which are connected to the end ring 9 since the positions of the apertures receiving the ends 7 and 8 ensure close contact of these lengths with the outer surface 2 of the stator 3.

The curvature of each section 6 of the pipe 1 is such that the natural circumferential length (when curved) of the assembly shown in Figure 4 is slightly less than the circumference of the outer surface 2 of the stator. The straight lengths 5 of the pipe are thus pressed closely against the outer surface 2 so as to make good thermal contact in the position as shown in Figure 3.

As shown in Figure 2 a hollow generally cylindrical space having an internal diameter equal to the internal diameter of the stator 3, an external diameter equal to that of the interior of the housing 4 (including the regions containing the pipe lengths 5 and clips 19) and extending from the mounting face 11 to the end of the housing further from the end ring 9, is filled with a suitable settable material such as an epoxy resin and cured, thereby encapsulating the stator, stator windings, pipe and clips. If necessary the interior surface of the cured epoxy resin may be machined so as to ensure that it has the correct internal diameter.

The casing in accordance with the invention and as shown in the drawings provides good cooling characteristics for the stator when a coolant such as water is pumped through the pipe 7 through the apertures in the mounting face 11. Further because the whole of the stator, associated windings

and coolant pipe is encapsulated, the motor can be used in a vacuum e.g. associated with and/or driving a vacuum pump, without any unwanted electric discharge or reduction in efficiency occurring.

CLAIMS:

1. A casing for an electrical machine having an inner rotor and an outer stator comprising a pipe of thermally conductive material for carrying coolant maintained in contact with the outer surface of the stator.
2. A casing according to Claim 1 wherein the pipe comprises a plurality of straight lengths located against the outer surface of the stator.
3. A casing according to Claim 1 or Claim 2, wherein the machine comprises an electric motor and the lengths extend along the outer surface of the motor stator, each length extending parallel with the rotational axis of the motor.
4. A casing according to either of Claims 2 or 3, wherein axially extending lengths of the pipes are joined by curved end sections so that the coolant flows in one direction along one length and in the opposite direction along the next adjacent length.
5. A casing according to any one of the preceding Claims wherein an outer housing is provided to surround axially extending lengths of the pipe whereby the pipe lies sandwiched between the outer housing and an outer surface of the stator.
6. A casing according to Claim 5, wherein the outer housing comprises a plurality of axially extending corrugations to define a plurality of recess regions at least some of which contain an axially extending length of the pipe.
7. A casing according to Claim 6, wherein each recess region contains an axially extending length of pipe.
8. A casing according to Claim 6 or Claim 7, wherein each or at least one said recess region contains two lengths of pipe.
9. A casing according to any one of the preceding Claims wherein bias means is provided to urge the pipe against the outer surface of the stator.
10. A casing according to Claim 9, wherein the bias means comprises spring means.
11. A casing according to Claim 10 when dependent on any one of claims 5 to 8, wherein the housing supports a plurality of spring clips arranged to urge the pipe against the outer surface of the stator.

12. A casing according to Claim 11, wherein at least some of the recess regions contain one of said spring clips to urge the two lengths of pipe against the outer surface of the stator.
13. A casing according to any one of the preceding Claims wherein the pipe is embedded in a settable material.
14. A casing according to any one of the of Claims 10 to 12, wherein the pipe and the spring means are embedded in a settable material.
15. A casing according to Claim 13 or Claim 14, wherein the settable material is an epoxy resin.
16. A casing for a rotatable electrical machine substantially as described herein with reference to the accompanying drawings.
17. An electric motor comprising a rotor, a stator which surrounds the rotor and a casing according to any one of the preceding claims arranged with the pipe thereof in thermal contact with the outer surface of the stator.
18. An electric motor according to Claim 17, wherein the location means is provided for location of and fluid interconnection with two ends of the pipe.
19. An electric motor according to Claim 18, wherein the motor comprises an end ring provided with two apertures respectively to act as location means to support said two ends of the pipe.
20. An electric motor according to Claim 19, wherein said apertures communicate with passages in a mounting face member secured to said end ring.
21. An electric motor according to Claim 20, wherein said mounting face member is provided with a sealing plug which is in sealed contact with cables connecting to motor windings.
22. An electric motor according to any one of Claims 18-21, wherein the spacing of the ends of pipe when in an unstressed condition is less than the major circumferential distance between the said location means whereby the pipe is inherently urged to bear against the **outer surface of the stator when it** has been subjected to applied forces to cause it to lie around the outer surface of the motor with the ends of the pipe in fluid communication with said location means.

23. An electric Motor substantially as described herein with reference to the accompanying drawings.

1/2

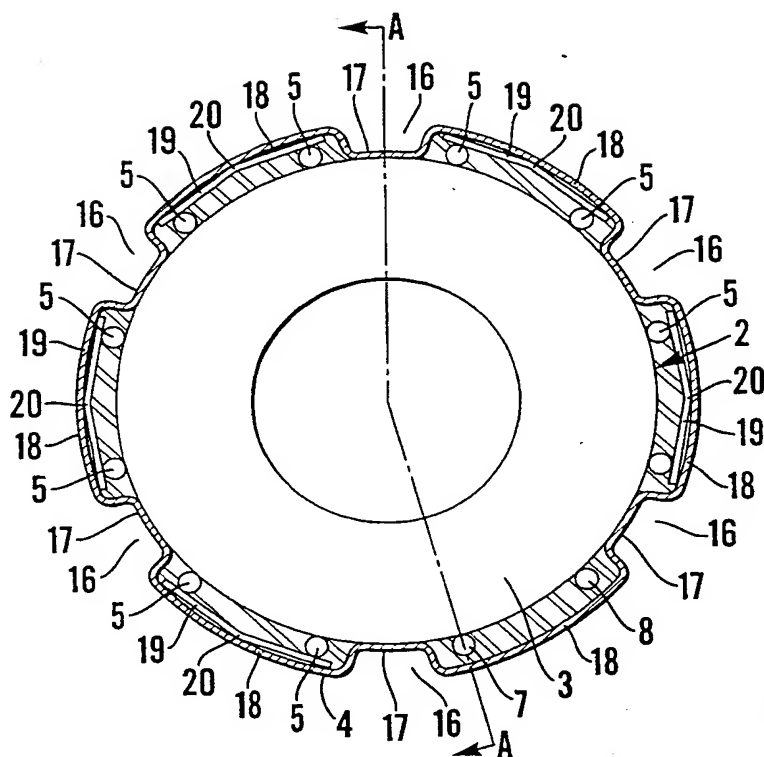


Fig. 1

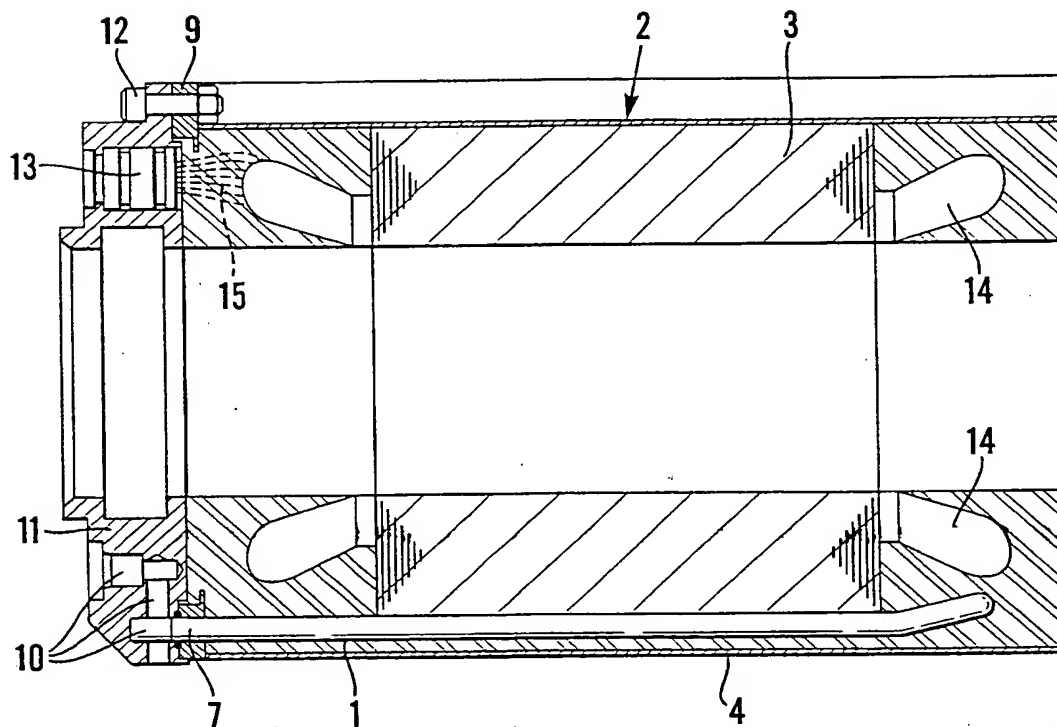


Fig. 2

2/2

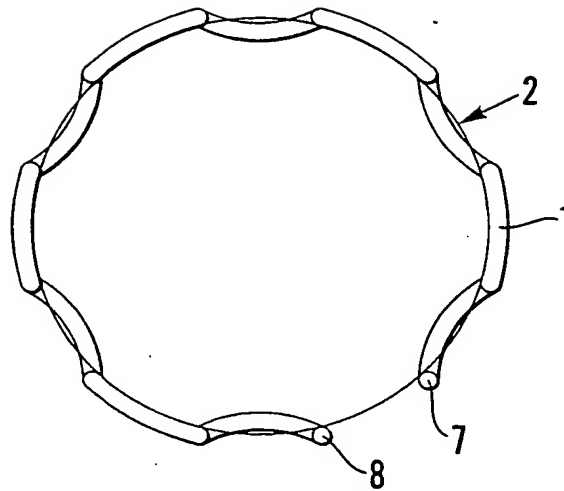


Fig. 3

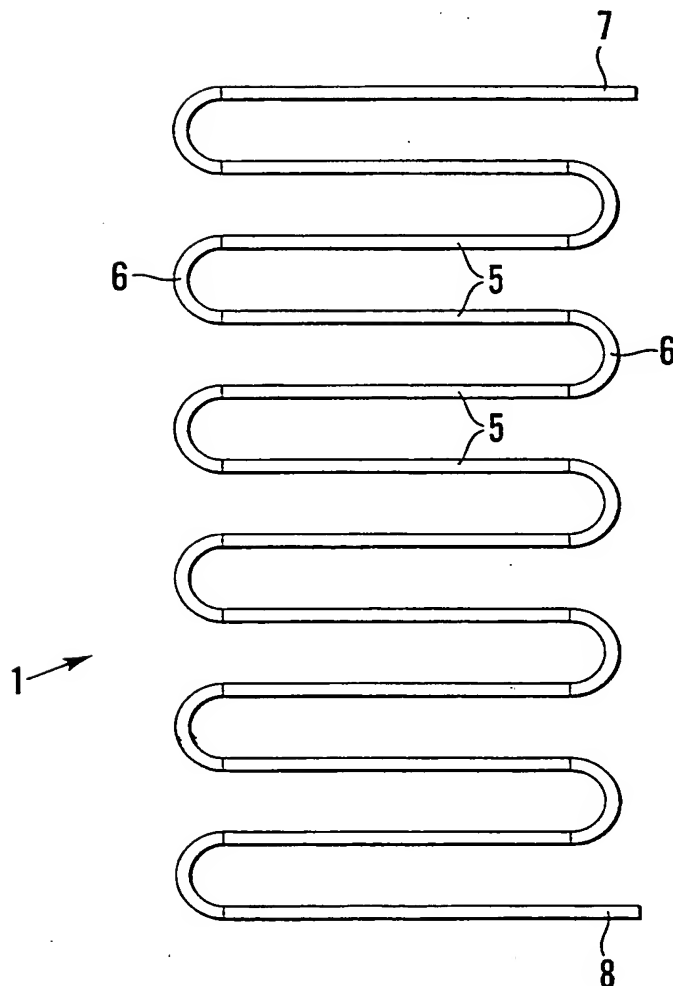


Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/03399

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02K5/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 890 687 A (ASSOCIATED ELECTRICAL INDUSTRIES LTD) 7 March 1962 (1962-03-07)	1-3,5, 17,18
Y	page 1, line 71 - line 88; figures 2,3	4
Y	US 1 607 288 A (C. M. LAFFOON) 16 November 1926 (1926-11-16)	4
	page 1, line 93 - line 98; figure 3	
X	EP 0 859 447 A (GEN ELECTRIC) 19 August 1998 (1998-08-19)	1-3,5, 17,18
	Abstract figure 8	
X	DE 297 14 614 U (SIEMENS AG) 30 October 1997 (1997-10-30)	17,18
A	page 4, line 23 - line 31; figures 1-3	19
	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 March 2000

Date of mailing of the international search report

16/03/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 851 epo nl,
Fax (+31-70) 340-3016

Authorized officer

Zoukas, E

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/03399

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 883 827 A (LAURENCE, SCOTT & ELECTROMOTORS) 6 December 1961 (1961-12-06)	1,17,18
A	page 1, line 55 - line 56 page 1, line 84 - line 89; figures 1,3,4,6	20,21
X	DE 196 26 213 A (BOSCH GMBH ROBERT) 2 January 1998 (1998-01-02) column 3, line 2; figure 1	1-3
X	US 3 127 530 A (H. T. WHITE) 31 March 1964 (1964-03-31) figure 2	1-3,5
X	FR 2 742 606 A (RENAULT) 20 June 1997 (1997-06-20) Claim 1 figure 5	1-3,5,17
A	DE 196 51 959 A (SIEMENS AG) 18 June 1998 (1998-06-18) Claim 1 figure 9	13-15

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/GB 99/03399

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 890687 A		NONE	
US 1607288 A	16-11-1926	NONE	
EP 0859447 A	19-08-1998	US 5859482 A	12-01-1999
DE 29714614 U	30-10-1997	NONE	
GB 883827 A		NONE	
DE 19626213 A	02-01-1998	NONE	
US 3127530 A	31-03-1964	NONE	
FR 2742606 A	20-06-1997	NONE	
DE 19651959 A	18-06-1998	AT 3236 U	25-11-1999